Attachment C

STATE OF MICHIGAN
MICHIGAN PUBLIC SERVICE COMMISSION

MICHIGAN BELL TELEPHONE COMPANY	)	
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	)	
In the matter, on the Commission's own motion, to consider the total service long run incremental costs for all access, toll and local exchange services provided by **AMERITECH MICHIGAN**	)))))	Case No. U-11831

DIRECT AFFIDAVIT OF

MICHAEL STARKEY

ON BEHALF OF MCIWORLDCOM

SCHEDULE 4

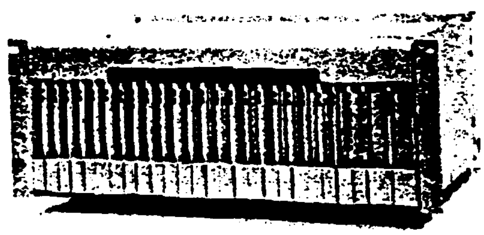
CONTAINS NO CONFIDENTIAL DATA

MCI WORLDCOM

Law and Public Policy

Unbundling

Digital Loop Carriers



February 1999

I. INTRODUCTION

The purposes of this paper are:

- to show that Integrated Digital Loop Carriers (IDLCs) can be unbundled;
- to describe four technically feasible unbundling methods available with IDLC equipment that is in-place or generally available today; and
- to show that converting an IDLC-served customer to all copper facilities or UDLC technology is a backward step in technology that actually degrades the customer's service.

Digital Loop Carriers (DLCs)[1] are widely deployed in the telecommunications network in place of expensive copper feeder. In addition to providing a cost-effective alternative to copper feeder in many situations, DLCs can extend potentially distance-restricted services such as ISDN farther away from the central office and can push switch-based functionality farther into the field to remote terminals.

Currently, 20 percent of the access lines in the United States are served by DLCs, and that penetration is projected to increase ultimately to 50 percent in urban areas and 80 percent in rural areas.[2]

DLC technology has been around since the 1970s, but there have been significant advances in the technology over the past two decades. Today there are two major types of DLC - Universal (UDLC), which was developed for an analog environment but can work, albeit inefficiently, in a digital environment, and Integrated (IDLC), which was developed specifically for a digital environment. There have been two "generations" of IDLC technology, which conform to two sets of specifications developed by Bellcore -- TR-008 and GR-303.[3] The Bellcore GR-303-capable IDLCs are the forward-looking technology being deployed today.

UDLC enters the central office switch in analog form, and therefore requires an analog-to-digital conversion when used with digital switches. By contrast,

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[1] The older generation of DLCs is sometimes referred to as Digital Line Concentrators.

[2] GR-303 technology and its deployment were the topic of Bellcore's GR-303 Integrated Access Symposium, San Diego, CA. July 29-30, 1998 www.bellcore.com/gr/gr303.html#forum.

[3] Some manufacturers have called their GR-303 IDLCs "Next Generation DLCs" (or NGDLCs) for marketing purposes, but these simply represent the manufacturers' latest GR-303-compatible IDLC offerings.

IDLC stays in digital form as it enters the local digital switch. Today, an incumbent local exchange carrier (ILEC) is unlikely to deploy a UDLC unless an analog switch serves the loop(s).

The notion that IDLC technology cannot be unbundled because it is integrated into the local digital switch is incorrect. As this paper will show, "integrated" does not mean inseparable or incapable of being unbundled. It is technically feasible to unbundle all IDLCs, including TR-008 and GR-303 IDLCs.

II. WHY LECs DEPLOY DLCs

A DLC is an electronic device that connects to customers' copper distribution pairs at a remote terminal, converts the analog signals to a digital multiplexed format, and then transports the digital signal over a fiber or copper transport to the local switch in the central office. Figures 1 (a), 1 (b), and 1 (c) show three scenarios that will be described in greater detail in this paper: UDLC connecting to an analog switch such as a 1A or crossbar; UDLC connecting to a digital switch; and IDLC connecting to a digital switch.

The multiplexing of the copper pairs reduces the number of pairs needed in the feeder portion of the loop plant (or eliminates the need for copper pairs altogether in the feeder network as they are replaced by fiber or digital transmission media). Indeed, for that reason, when DLC technology was first introduced it was often referred to as "pair gain" technology. In addition, DLCs are more economical to deploy for loops longer than 9,000 feet than are large, expensive copper feeder cables. Companies sometimes perform a cost-benefit analysis to prove in DLCs by comparing the DLC costs to the cost savings from not having to reinforce existing cables or not having to obtain additional room on poles or place additional conduits.

Also, deployment of DLCs in concert with the Carrier Serving Area (CSA)/ISDN design criteria developed by the industry, allows a carrier to provide digital services (such as ISDN service) that cannot be provided over loops that exceed 18,000 feet.[4] (See Figure 2). In addition, DLCs bring some switch-based functions out to the field. For example, many GR-303-equipped DLCs poll customer lines for an off-hook condition, perform concentration functions, and extend services such as ISDN further out into the central office serving area.

[4] The CSA/ISDN design specifies loop lengths of less than 18,000 feet, non-loaded loops, and no bridge taps (over 24 AWG wire). The CSA/ISDN design enables more efficient and cost effective deployment of DLC technology, makes more efficient use of the in-place cables, and reduces ongoing cable reinforcement construction costs.

III. UDLC vs. IDLC

A UDLC consists of a remote terminal (RT), a digital transmission (transport) facility to link the RT to the central office (CO), and a central office terminal (COT). (See Figures 1 (a) and 1 (b).) The RT aggregates the copper pairs and performs conversions -- converting the customer's analog signal to a digital multiplexed format going to the central office, and (in the opposite direction) converting the digital signal from the central office to the customer to an analog signal. The transport carries the digital signal from the RT to the COT, and vice versa. The COT equipment converts the digital signal from the RT to an analog signal before the signal is terminated on the Main Distributing Frame (MDF)[5] and cross-connected to the switch port.

It is at this point that the equipment needed differs depending on whether the CO switch is analog or digital. Where a UDLC is connected to an analog switch (see Figure 1 (a)), after the individual voice-grade analog circuits are terminated on the MDF, they are cross-connected into and out of the switch using a Line Relay, which is the analog interface to the analog switch.

In the case where a UDLC is connected to a digital switch (see Figure 1 (b)), the signal is cross-connected on the MDF to an analog port (called an Analog Interface Unit or AIU) on the switching system. At the AIU, the signal that was converted from digital to analog at the COT is now converted back to digital -- and, in the other direction, the digital signal from the switch is converted to analog before being sent to the COT where it will be converted back to digital.

As digital switches were deployed, the required digital-to-analog conversion at the central office for UDLCs became redundant, inefficient, and expensive. Thus, the "integrated" DLC was developed and introduced.

The term "integrated" DLC was coined to differentiate the IDLC from the older UDLC technology. Specifically, it meant the elimination of the DLC central office terminal, of switch line cards, and of analog-to-digital (A/D) or digital-to-analog (D/A) conversions at the CO. In short, the IDLC could be digitally connected to the switching system. However, this does not connote that the DLC is inseparable, indivisible, or incapable of being unbundled, nor that the service is inseparable from the ILEC switch. As will be described in detail below, an IDLC can be digitally connected to more than one switch simultaneously (this is called Multiple Switch Hosting) by separating and unbundling digitally encoded voice (and data) channels.

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[5] The COT equipment also converts the analog signal coming from the switching system to a digital signal to be sent to the RT.

As shown in Figure 1 (c), the basic IDLC system consists of an IDLC RT, a digital transmission facility with various pieces of equipment and an Integrated Digital Terminal (IDT) in the switch.

The IDLC RT (see Figure 3) consists of channel units (customer interface cards), power supply, a Time Slot Interchanger (TSI) that performs electronic cross-connect functions, interface groups that aggregate traffic into specific interface formats,[6] and a multiplexer (mux) to consolidate or aggregate the signals for transport to the CO. These main components of an IDLC RT are all contained within a cabinet that ranges from the size of a Network Interface Device (NID) -- a wall mount to a large wall-to-wall bookshelf (for example, a Lucent 80D cabinet) depending on the vendor and number of lines served. Currently IDLC RTs can handle from 24 to 2,016 lines. Copper distribution cable, as opposed to coax or fiber, connects the customer to the RT and is still the most economical way to provide basic telephone service.

A digital transmission facility or digital transport connects the RT to the central office.[7] In the digital transport connecting the RT to the central office, various pieces of equipment must be used to de-multiplex (break down) the transport medium into individual DS1s in order to "hand-off" the DS1s to the digital switch. (See Figure 1 (c)). If the transmission medium is fiber, the signal goes through a Light Guide Cross-connect (LGX),[8] a fiber multiplexer (mux),[9]

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[6] These will be described in greater detail later and are shown in Figure 4.

[7] Early DLC applications used T-1 carrier on copper pairs. In addition to T-1 over copper, both Synchronous (SONET) and asynchronous fiber optic transport are utilized, depending on the application, size, location, and condition of the outside plant. Generally, larger DLC systems transport is on fiber at the SONET OC-3 (155 Mb/s or 84 DS1s or 2,016 DS0s) rate. In addition to OC-3, OC-1, OC-12, and DS-2 over fiber are also common options. SONET technology is preferred and has replaced other transport mediums because it dramatically reduces multiplexer costs and because of its inherent Add-Drop and Ring capabilities. Add-drop capability is the ability to accept or drop-off groups of circuits (virtual tributaries) from the SONET device without any additional multiplexing equipment while simultaneously providing transport to preceding and succeeding SONET muxes. Ring capability is the ability to connect multiple SONET muxes into one of several types of ring topologies such that service is maintained when one "leg" of the (ring topography) transport is severed. This is a common technique used to ensure survivability of the fiber transport.

[8] The Light Guide Cross-Connect is a device upon which the fiber from the outside is terminated and cross-connected with fiber "pigtails" to the fiber mux in the CO. The pigtails are single fibers designed to be inserted into the LGX to mix and match fiber inputs from the outside fiber cables. Essentially, the LGX is a fiber MDF.

[9] The fiber mux or SONET mux is a device that takes (electrical) digital signals (cross-connected via the DSX) and converts them into optical signals or vice-versa. For instance, an OC3 mux can take a maximum of 84 DS1s and convert them into a single optical bit rate speed of approximately 155 Mb/s with an encoding technique called Time Division Multiplexing, hence, the term mux. There are synchronous (SONET) and asynchronous muxes. An Add-Drop Mux (ADM)

and a digital signal cross connect (DSX) device. If the transmission medium is copper, there is no need for an LGX. Whatever the transport medium, the DSX is the device used to cross-connect the DS1s to the digital switch. Essentially, the DSX is a digital MDF, which allows DS1s to be cross-connected to various devices in the CO. For either fiber or copper transport, the signal remains digital and terminates at the integrated digital terminal in the digital switch.

The Integrated Digital Terminal (IDT) is a digital interface component of the local digital switch where the DS1s from the IDLC RT are terminated and includes a Time Slot Interchanger that performs electronic cross-connects.

Because of the digital nature of IDLCs, the MDF, which is the traditional demarcation point between the copper loop and the switch, is not the demarcation point for the IDLC-served loop. Instead, an IDLC loop is cross-connected electronically at the RT, and the physical demarcation point for an IDLC-served loop is in the CO at the Digital Signal Cross-Connect (DSX). The DSX is a manual cross-connect device for DS1s[10]. IDLC loops are transported in groups of 24 circuits within each DS1, and DS1s are typically terminated and cross-connected at a DSX. This has the added advantage of making collocation unnecessary for access to these loops[11] and keeps the signal(s) in digital form.

1. ADVANTAGES OF IDLC

IDLC-provisioned local loops are provided more efficiently and cost effectively than UDLC-provisioned loops because an IDLC requires neither an analog conversion at the CO, nor the AIU line card at the switch, nor manual MDF wiring since this is only required for analog loops. As a result, compared to today's IDLCs, UDLCs require a lot of unnecessary investment for digital-to-analog and analog-to-digital conversion equipment and MDF wiring in the central office. UDLCs also require substantial and unnecessary investment for switching equipment and the associated real estate and power requirements to convert the analog signal back to digital because today's digital switches require a digital signal.

In addition, the back-to-back digital-to-analog and analog-to-digital conversions inherent in the UDLC configuration reduce bit rate speeds for voice band data connections such as faxes or analog modems. Moreover, customers

is a SONET mux that is capable of dropping off or accepting groups of DS1s while simultaneously providing transport to preceding and succeeding muxes.

[10] DS1s terminate on a DSX-1, whereas DS3s can terminate on a DSX-3.

[11] The CLEC can purchase or provide dedicated transport from the DSX to their CO to transport their loops.

served by UDLC technology cannot receive ISDN and ADSL services without the installation of additional external loop electronics and digital transmission bandwidth at the UDLC, because UDLCs were neither designed nor have the capability to handle the bandwidth requirements of ADSL and ISDN.[12]

Consequently, the UDLC configuration is inefficient in today's digital network, would not be the technology of choice today for ILECs putting in additional DLCs served by digital switches, and does not represent a forward-looking technology[13].

2. TYPES OF IDLC CONFIGURATIONS

TR-008

The most prevalent IDLC configuration in place is the Bellcore TR-008 digital switch interface. This configuration evolved from the proprietary interface existing at divestiture, when the RBOCs had a large embedded base of Western Electric (now Lucent Technologies) SLC® 96 IDLCs that were only compatible with Western Electric switches.

With the break-up of the vertically integrated Bell System, the RBOCs and ILECs could look to other equipment vendors, but given the large embedded base, these companies demanded that other switch vendors, such as Northern Telecom and Siemens Stromberg-Carlson, make their switch interfaces SLC 96-compatible. Because of this customer demand, Bellcore defined the TR-008 specifications so switch vendors could make their products compatible with the Western Electric SLC 96 IDLC. The existence of non-proprietary specifications helped spawn new DLC vendors. Today many vendors' IDLCs can integrate with the TR-008 digital switch interface. The TR-008 interface was vastly superior to UDLC systems, as explained earlier, and gave the telephone companies a choice in DLC equipment.

The TR-008 interface comes in two flavors: mode 1 and mode 2. Mode 1 consists of four DS1s (24 channels or DS0s per DS1 or 96 total DS0s) that serve up to 94 customers or one 64 Kb/s DS0 per customer on a dedicated basis. Mode 2 uses two DS1s to serve up to 94 customers or 4 DS1s to serve up to 188 customers.

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[12] Therefore, where ILECs have proposed to provide CLECs seeking unbundled DLC loops only UDLC loops, but not IDLC loops, CLECs would be precluded from offering ISDN and ADSL services over those loops.

[13] There may be a few exceptions for private line service.

As Bellçore released the more technologically advanced GR-303 specification, many equipment manufacturers developed equipment to meet this newer specification.[14] Anticipating the release of the GR-303 specification, many built their TR-008 IDLCs such that they could be upgraded to GR-303. Consequently, many of the IDLCs deployed by ILECs today are capable of complying with both Bellcore's TR-008 and GR-303 standards. However, there are some older TR-008 IDLCs that cannot be upgraded to GR-303.

GR-303

In response to telephone companies' demand for an IDLC that could interface more efficiently than the TR-008 with the digital switch, and could extend the ISDN signal to customers served by facilities exceeding the maximum ISDN loop length requirements, Bellcore developed GR-303. These specifications are defined in Bellcore's Generic Requirements "GR-303, Integrated Digital Loop Carrier System Generic Requirements, Objectives and Interface." GR-303 enabled the IDLC to dynamically allocate transport bandwidth by assigning a channel to customers on a call-by-call basis rather than dedicating channels to customers. It improved transport efficiency by extending the switch concentration ratio out to the IDLC. For example, a 4:1 concentration ratio GR-303 IDLC can serve approximately twice as many customers as a TR-008 (mode 1, 4 DS1s) IDLC, with half as many DS1s (two DS1s, 188 customers). The concentration ratio is also scaleable, depending on the customer's traffic usage requirements.[15] As shown in Figure 4 and described in detail in Section IV, the GR-303 interface group can handle far more traffic than the TR-008 interface group. Also, GR-303 IDLCs efficiently support ISDN, resulting in more efficient transport and switching utilization

The GR-303 interface has capacity for a minimum of two DS1s[16] and a maximum of twenty-eight DS1s. As shown in Figure 4, the first DS1 in the GR-303 Interface Group contains an Embedded Operations Channel (EOC) and a Time Slot Management Channel (TMC), and 22 DS0 channels. The EOC provides a communication path for operations and maintenance. The TMC assigns time slots for voice grade circuits (DS0s) and the ISDN B-channels. These functions –

[14] Vendors and products include, DSC Litespan 2000, Lucent SLC 2000, NORTEL Access Node, and RELTEC DISC*S. The latest IDLCs include Lucent's AnyMedia, Fujitsu's FACTR, AFC UMC-1000, and DSC's Litespan ADSL

[15] The concentration ratio is determined by the number of DS1s provisioned, which is engineered based on IDLC customers' traffic requirements and is (usually) engineered to the same requirements as a direct line-side analog interface at the digital switch.

[16] One DS1 may be used if redundancy is not required.

and thus the two channels - are needed for GR-303 to provide variable concentration and bandwidth assignment.

The second DS1 has backups for the EOC and TMC channels to provide redundancy, and 22 DS0 channels. The remaining DS1s do not need their own EOC or TMC, and thus each has the full complement of 24 channels

As shown in Figure 5, the GR-303 IDLC RT can simultaneously accommodate TR-008 interface groups, GR-303 interface groups, and Integrated Network Access (INA)[17] interface groups. As discussed in greater detail in Section IV, this capability allows a GR-303 IDLC to integrate with several switches simultaneously.

The GR-303 IDLC technology provides a highly efficient and very powerful DLC network for local loops. Most GR-303 IDLCs have been constructed to support UDLC operation and/or TR-008 integration because manufacturers have had to be sensitive to carriers' embedded base of analog switches. While these GR-303 IDLCs can be configured to operate in UDLC mode, they are not UDLCs.

Many ILECs are deploying GR-303 capable IDLCs in their networks today,[18] and the trend is expected to increase because GR-303 is much more efficient, and IDLC costs are decreasing while other outside plant costs increase.[19] Table 1, from the Bellcore DLC Trends presentation at the GR-303 Integrated Access Symposium, shows the percentage of working lines served by all DLC technologies and by GR-303-capable DLC, for the RBOCs and GTE. This suggests an overall penetration rate of about 20 percent and a GR-303-capable penetration rate of 10 percent.[20]

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[17] INA will be discussed in the next section of this paper.

[18] See, for example, DLC Trends presentation by Bellcore at GR-303 Integrated Access Symposium, San Diego, CA, July 29-30, 1998 - www.bellcore.com/gr/GR303.html#forum. Nationally, the average annual increase in DLC served lines is approximately 20 percent, compared to an annual growth in access lines of 3 to 5 percent.

[19] Since the use of GR-303 technology requires both software and hardware upgrades to many embedded switches, at least one ILEC (PacBell) has stated that in many situations GR-303 does not "cost out" and therefore it does not intend to deploy it widely. This raises an important public policy issue. Is the PacBell decision based strictly on the merits of the technology or is it skewed by the strategic consideration that deployment of GR-303 will remove a barrier to competitive entry? That is, is a decision not to deploy the technology beneficial to PacBell shareholders but inconsistent with the public interest in fostering competition?

[20] Data presented by Westell at a recent DSL conference corroborates these numbers. Of the approximately 35 million lines served by DLC (out of approximately 172 million access lines nationwide), 7.5 million are SLC96, 15 million SLC5, 2.5 million SLC2000, 7 million DSC Litespan,

Table 1
Percent of Working Lines Served by DLCs

	GR-303 Capable DLC	*All DLC Technologies*
Ameritech	6%	13%
Bell Atlantic	18%	32%
BellSouth	17%	36%
GTE	6%	16%
NYNEX	7%	13%
Pacific Telesis	3%	6%
Southwestern Bell	7%	14%
US West	10%	17%
National Total	10%	20%

3. SUMMING UP GR-303 ADVANTAGES

Bandwidth Efficiency

The GR-303 IDLC provides for significant efficiencies by moving the concentration function from the switch to the RT. GR-303 makes very efficient use of the transport bandwidth medium and switch terminations by assigning a channel to the customer on a call-by-call basis as opposed to "nailing up" or dedicating the channel, as in TR-008. Hence GR-303 requires less bandwidth and switch terminating capacity than a TR-008 IDLC or a UDLC.

ISDN Provisioning

Prior to the availability of GR-303, ISDN provisioning on DLCs was expensive because it required using external equipment such as BRITE cards and was inefficient because three DS0s were needed to carry the ISDN 2B+D channels. Because GR-303 IDLCs are designed to deliver ISDN, ISDN can be provisioned as easily and efficiently as POTS.

and 3 million others (Nortel, Fujitsu, AFC, Reltec, etc.). Source: Westell, Commercializing DSL Technologies presentation, September 25, 1998, Atlanta GA.

Optimizing OSS

GR-303 has been developed to operate in conjunction with forward-looking operations support systems such as OPS/INE, which provide for highly automated, centralized, and remotely located operations centers. GR-303 also supports digital connectivity for non-locally-switched services, such as foreign exchange lines, and non-switched services, such as Digital Data Service or DS0 private lines.

IV. UNBUNDLING ALTERNATIVES

Some parties have claimed that since an IDLC signal is digital and is connected to the switch IDT there is no way to unbundle the IDLC. They further contend that because it is allegedly technically unfeasible to unbundle IDLC loops, an ILEC customer currently being served by an IDLC loop who chooses to get service from a CLEC using unbundled ILEC loops could not stay on the IDLC loop. Rather, the customer's service would have to be put onto an analog loop (spare or retired copper loops or a UDLC). In fact, there is no technical impediment to a customer receiving service from a CLEC via an unbundled ILEC IDLC loop[21].

Unbundling of IDLCs is technically feasible, provides non-discriminatory access to end-to-end digital services, and is less disruptive to the customer than moving the service off of the IDLC. Placing an IDLC served customer onto a UDLC harms the customer because it is a lesser grade of service due to the extra analog-to-digital conversions required. The customer's analog signals would not be at parity with the IDLC-provided service. In addition, the customer probably would experience provisioning delays because UDLC or copper-fed service requires manual MDF cross-connects as opposed to electronic provisioning with IDLCs.

There currently are four technically feasible unbundling methods that can provide CLECs with non-discriminatory access to the customers served by IDLCs:

1. Multiple Switch Hosting

2. Integrated Network Architecture (INA)

[21] This assumes that the ILEC owns and controls the network and is simply handing off traffic to the CLEC through interconnection. If, however, CLECs co-own the RT and want to provision services themselves, some technical problems may occur such as access to a single alarm group in the RT. These problems are currently being addressed by the industry.

3. Digital Cross-Connect System (DCS) Grooming
4. Side-Door Grooming

1. Multiple Switch Hosting

Multiple Switch Hosting is the ability of one IDLC RT to interface with multiple switches simultaneously. It allows the IDLC technology residing in the RT to serve the ILEC plus multiple CLEC switches. Multiple Switch Hosting is possible because all GR-303 IDLCs have a Time Slot Interchanger (TSI) that allows a CLEC customer(s) to be assigned to CLEC-specific channelized DS1s served by the RT. That is, the ILEC and each CLEC can be assigned one or more DS1s (with each DS1 having up to 24 distinct DS0 (voice grade) channels), with their customer traffic routed to their assigned DS1s. This is accomplished by "field grooming"[22] at the RT - the process of using the TSI in the RT to map specific DS0s to specific DS1s or groups of DS1s, called "interface groups," as shown in Figure 5. If the customer changes his or her service back to the ILEC or to another CLEC, field grooming allows the appropriate cross-connects to be made electronically in the same manner as described above.[23]

As mentioned earlier and shown in Figure 5, the GR-303 IDLC RT can simultaneously support interface groups for the TR-008 interface format, the GR-303 interface format, and the INA interface format. This Multiple Switch Hosting capability allows a single IDLC to interface with several switches simultaneously,[24] with more than one type of switch interface (GR-303, TR-008, and/or INA) protocol. The Multiple Switch Hosting capability exists in most of today's IDLCs, and Bellcore's GR-303 specifications require the capability to be integrated with a minimum of two switches. Some vendors already provide Multiple Switch Hosting with up to five different switches and may soon be able to do so with up to eight.

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[22] The grooming is done in software and no field visits are ever required. Field grooming simply means that the grooming occurs in the field as opposed to the central office.

[23] Field grooming at the RT requires that each customer be assigned a Line Circuit Address (LCA) and Call Reference Value (CRV). The customer's copper pair is terminated at the RT and is assigned a CRV in the appropriate GR-303 Interface Group, via the OSS interface. With multiple GR-303 Interface Groups, a CRV of any Interface Group can be assigned to the LCA corresponding to a customer's number. The GR-303 Interface Group uses the CRV in the Timeslot Management Channel to dynamically assign DS0s or fractional DS0s to a circuit on a call by call basis as directed by the TSI. This means, unlike TR-008, no DS0s are permanently assigned to any line. The CRV is assigned to an interface group (in software) to a LCA via a table in both the switch IDT TSI and the IDLC TSI. Figure 5 depicts a multi hosting capable IDLC.

[24] The number of integrated switches to a RT is a software capability inherent in the GR-303 specification.

Multiple Switch Hosting requires the use of one of the forward-looking operational support systems currently available, such as OPS/INE, and software provided by the IDLC vendor, in conjunction with the Time Slot Interchanger, to migrate a customer among local service providers.

First, the signal is electronically cross-connected by the RT's Time Slot Interchanger where it is placed on a DS1 in the appropriate GR-303, TR-008, or INA interface group. The traffic is fed into the RT's fiber mux and then transported over fiber (on a CLEC or ILEC channelized DS1) to the CO, where the fiber is terminated onto the LGX and cross-connected to the CO fiber mux. (See Figure 6). The fiber mux decodes the optical signal into electrical DS1s that are then connected to the DSX patch panel, where the respective DS1s are handed off to the ILEC or CLEC equipment. The reverse is true for traffic flowing in the other direction. From here a CLEC can buy dedicated transport or use its own fiber or copper from the ILECs DSX panel to the CLEC CO, and interface the DS1 signal into its own IDT. This is the simplest and quickest option for CLECs to get the digital loop. Alternatively, a CLEC can take the DS1 signal from the DSX to its collocation cage. Collocation, while sometimes desirable for things such as testing, is technically unnecessary for DS-1 level signals.

The Multiple Switch Hosting capability is the recommended forward-looking network architecture for unbundling in a competitive environment because, regardless of the local service provider, carriers have equal and non-discriminatory access to the capabilities of this highly efficient, high-quality digital local loop facility.

2. INTEGRATED NETWORK ACCESS (INA)

INA is an architecture inherent in IDLCs that allows specific DS0s to be mapped (groomed) into a unique interface group. This offers another method of unbundling GR-303 IDLC, albeit less efficiently than the GR-303 or TR-008 interface groups described by the Multiple Switch Hosting section above.

Originally, INA was designed to enable non-locally switched (FX service) and non-switched service (private line) DS0s to be terminated and redirected to the interoffice transmission network.[25] INA is another method of unbundling a GR-303 IDLC because the TSI can map (field groom) specific DS0s into specific Integrated Network Access groups as D4 formatted[26] DS1s. (See Figure 7.) This

[25] Bellcore, GR-303, IDLC Generic Requirements, Objectives and Interface, page 1-3, paragraph 1.3.1.

[26] D4 is a T1 framing format that does not have bit error rate detection.

D4 format signal then goes to a CLEC "city ring" or collocation area where the INA DS1s are first terminated onto another IDLC (often called the unbundling RT) that converts the INA DS1 to GR-303 DS1s, which then go to the CLEC's switch IDT.

In this scenario, the CLEC would have the technologically feasible option of collocating or not collocating the unbundling RT. In most situations, it is more efficient for the CLEC to access the INA DS1s without any sort of collocation arrangement.

The INA option may force a CLEC to invest in an unbundling RT in its collocation area or CO, and therefore is less efficient than the Multiple Switch Hosting (GR-303, TR-008) solution. Multiple Switch Hosting is not widely available today, however, and in its absence some CLECs currently are using the (INA) unbundling technique to provide service to IDLC-served customers.

In the past, INA use was limited to special services provisioning. Some CLECs, facing the current paucity of GR-303 interface groups supported by some DLC products, have resorted to a second-best solution and used INA for regular POTS switched services. This essentially allows any number of CLECs to interconnect to the IDLC. The number of available INAs is only limited by the DS1 capacity of the transport system (e.g., 84 DS1s for a SONET OC-3 system) minus any DS1s used for GR-303 or TR-008.

3. DIGITAL CROSS-CONNECT SYSTEM (DCS) GROOMING

A DCS (pronounced daks) is an intelligent software-based network device used in the central office to electronically cross-connect DS0s between multiple DS1s using its inherent Time Slot Interchanger.[27] This is called DS0/DS1 grooming. When unbundling the large embedded base of TR-008 systems, a DCS can be used to unbundled IDLC remotes by grooming the DS1s and redirecting DS0s within specific DS1s to the ILEC or CLEC(s). While a DCS can support TR-008 integrated interfaces, it is incompatible with GR-303 because it does not support the Embedded Operations Channel and Time Slot Management Channel that dynamically assign time slots on a call-by-call basis and communicate with the IDLC and IDT. It thus cannot take advantage of the efficiencies associated with GR-303.

Using a DCS may be the most efficient method of unbundling those DLCs (such as the SLC 96) that cannot support GR-303, INA, or Multiple Switch

[27] Lucent Technologies - DACS II Release 7.0 PDS Operations and Maintenance Manual Volume 1 - Acceptance and Operations - 365-353-051 Issue 1, Section 1.2.1 — DACSII Overview.

Hosting. Also, DCS grooming can be used where the TR-008 IDLC has a limited quantity of TR-008 interface groups. In addition, DCS grooming makes it unnecessary to undertake any changes at the IDLC RT, as all of the DS0 redirecting is done electronically by the DCS in the CO. It can also be used for small quantities of loops as an interim measure, until either Multiple Switch Hosting or INA is available. DCS grooming is shown in Figure 8. New facility-based service providers can use a DCS to interconnect with the embedded base of TR-008 IDLCs operating in Mode 1, eliminating the need to first convert the signal to analog or incur replacement or upgrade costs on older IDLCs.

4. SIDE-DOOR GROOMING

Side-door grooming (also known as hair-pinning) is a switch-based technology that requires that the Time Slot Interchanger in the IDT of the digital switch collect and route DS0s from a DS1 port connected to the GR-303 IDLC remote to another DS1 port on the IDT for interoffice connection. See Figure 9. Side-door grooming is done in the D4 format and is only utilized for special circuits where the quantities are insufficient to warrant the cost of deploying a DCS. A major disadvantage of the side-door technique (in addition to the D-4 format) is it unnecessarily and quickly consumes ILEC IDT switch resources, since an IDT time slot is nailed up to the IDLC DS0s. Multiple Switch Hosting and INA are more efficient unbundling techniques.

Until Multiple Switch Hosting or INA is more widely available, side-door grooming may be used to unbundle a few lines since the Time Slot Interchanger at the IDT provides the same functionality as the Time Slot Interchanger at the RT. However, this is the least desirable unbundling technique.

V. CONCLUSION

GR-303 IDLC is the forward-looking DLC technology deployed in the network today because of its transmission quality, range of service capabilities, and cost efficiencies. Many CLECs have deployed Bellcore GR-303-compliant IDLC technology in their networks because it expands network capability and is cost-effective, thus benefiting consumers in two ways. But consumers will not benefit from the new technology if their decision to be served by a CLEC using unbundled ILEC loops results in their being forced off IDLC loops.

Today it is technically feasible to unbundle IDLCs. The most efficient way to provide unbundled GR-303 IDLCs is through Multiple Switch Hosting. Absent sufficient GR-303 interface groups at the IDLC RTs, Multiple Switch Hosting can also be accomplished via TR-008 and INA interface groups. Multiple Switch

Hosting as well as the other techniques described in this paper enable IDLC unbundling and digital signal handoff to CLECs.

The UDLC and all copper facility forms of DLC unbundling are inferior. Placing a CLEC customer on a UDLC from a GR-303-capable or TR-008 IDLC is unnecessary and unacceptable because of the signal degradation and longer provisioning time for this archaic analog manual technology. TR-008 handoff, while better than a UDLC solution, is inferior to GR-303 because it does not offer variable concentration and does not utilize transport efficiently. However, TR-008 and INA are adequate interim unbundling solutions.

Upgrading of GR-303 IDLC systems represents a normal and necessary network modernization path because the technology is more efficient and offers better service to customers served by IDLCs. But ILECs will have an incentive to delay these network upgrades to curtail CLEC access to unbundled IDLCs. The public policy problem that regulators must grapple with is how to foster deployment of these new, efficient technologies when incumbent LECs recognize that such deployment also fosters competition.

To ensure that the advantages of these new technologies are available to CLECs and their customers, regulatory authorities should:

1. Rule that it is technologically feasible to digitally unbundle IDLCs and require CLEC access to unbundled IDLCs without manual intervention.

2. Identify GR-303 and Multiple Switch Hosting as the forward-looking IDLC technology to be used in determining recurring and non-recurring rates for unbundled loops.

3. Ensure that CLECs receive GR-303 digital signal from GR-303 capable IDLCs whenever technologically feasible.

4. Require IDLCs to be unbundled using Multiple Switch Hosting whenever and wherever technically feasible.

5. Order TR-008 or INA unbundling until GR-303 is deployed.

6. Ensure future GR-303 requirements provide open equivalent interfaces to all carriers on an equal and non-discriminatory basis.

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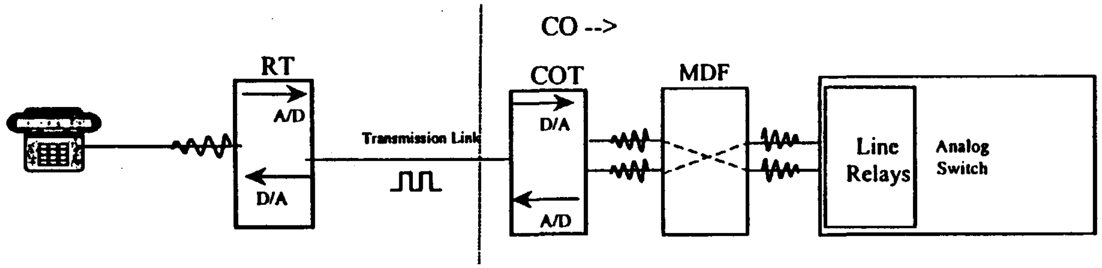

Figure 1 (a) - UDLC with an analog switch

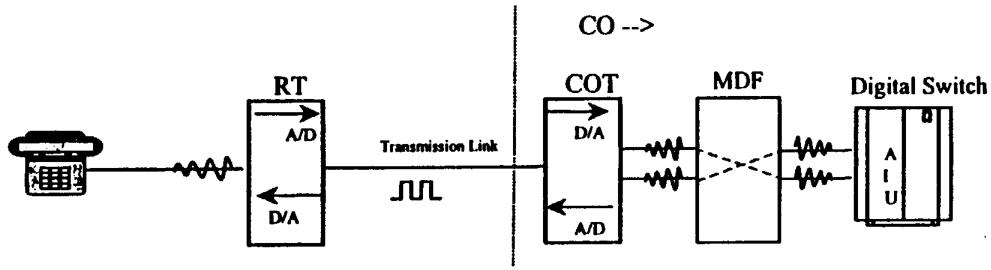

Figure 1 (b) - UDLC with a digital switch

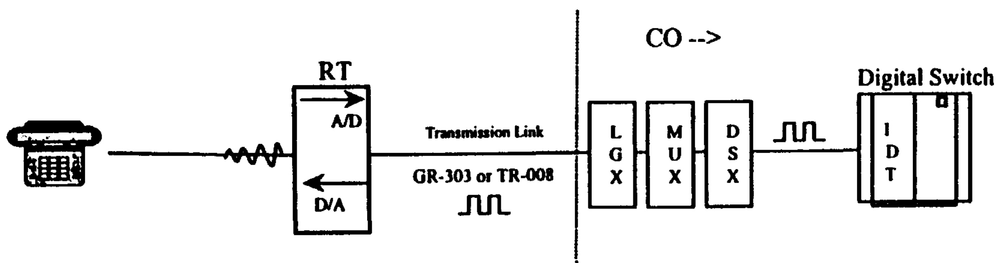

Figure 1 (c) - IDLC with a digital switch

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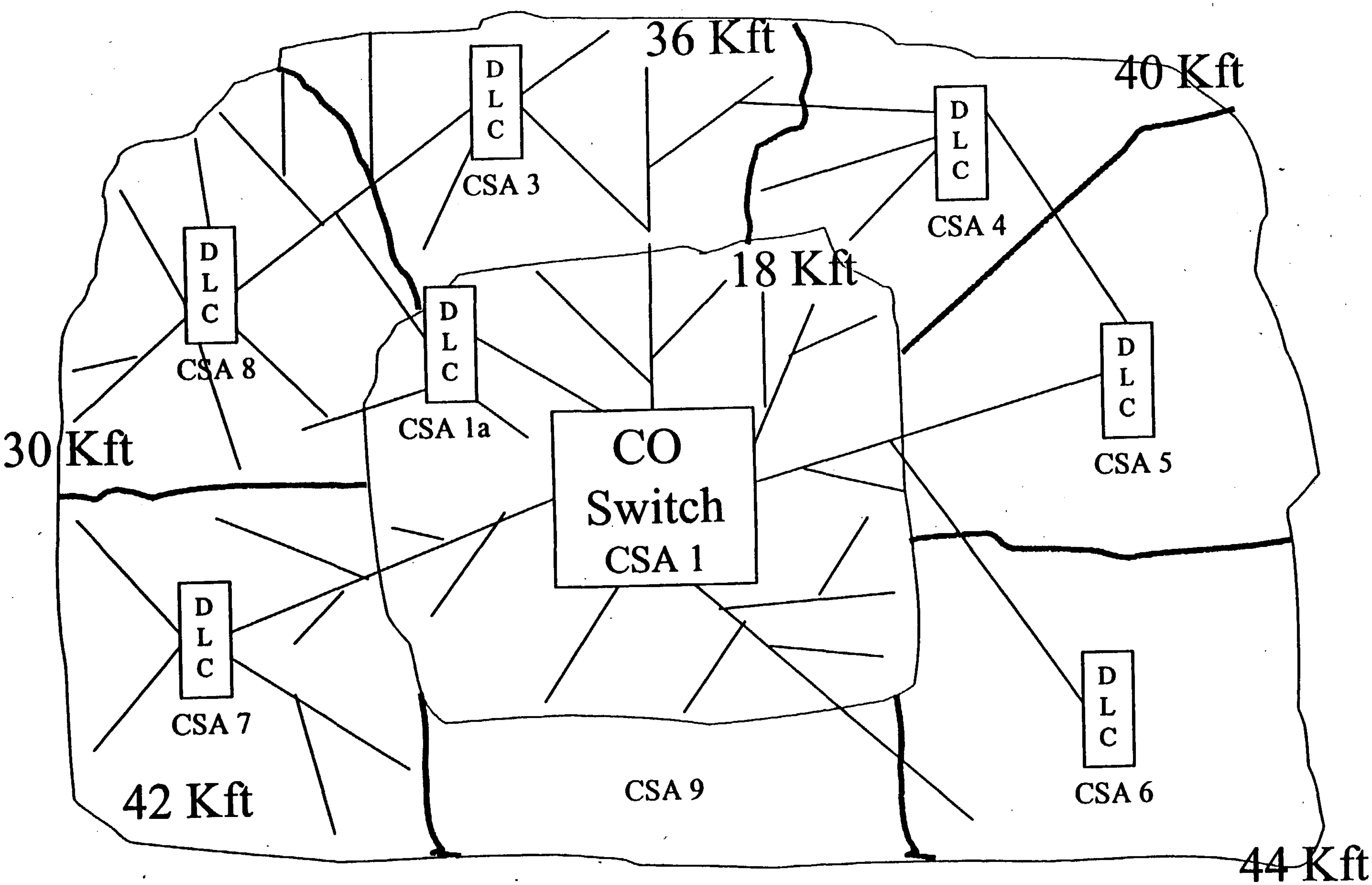

Figure 2 CSA Design Sketch

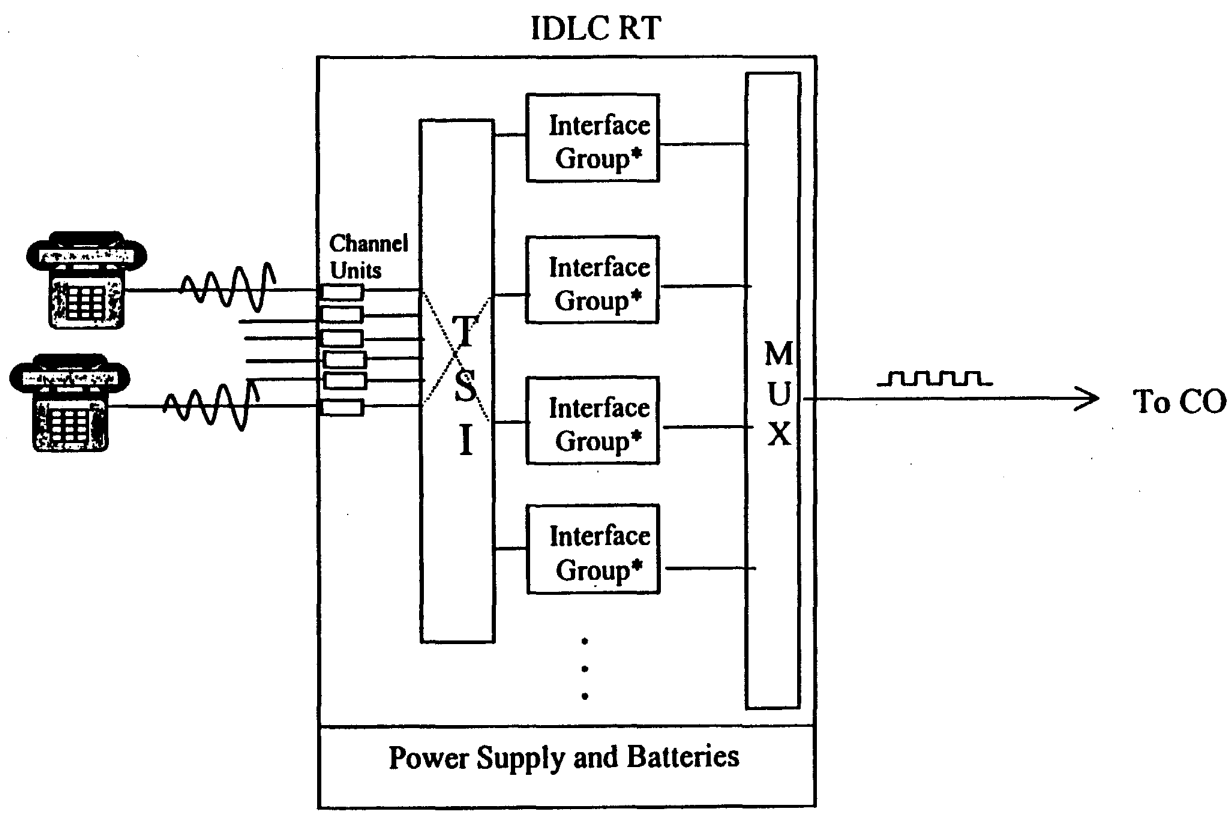

Figure 3 Generic IDLC RT
* interface groups can be TR-008 or INA

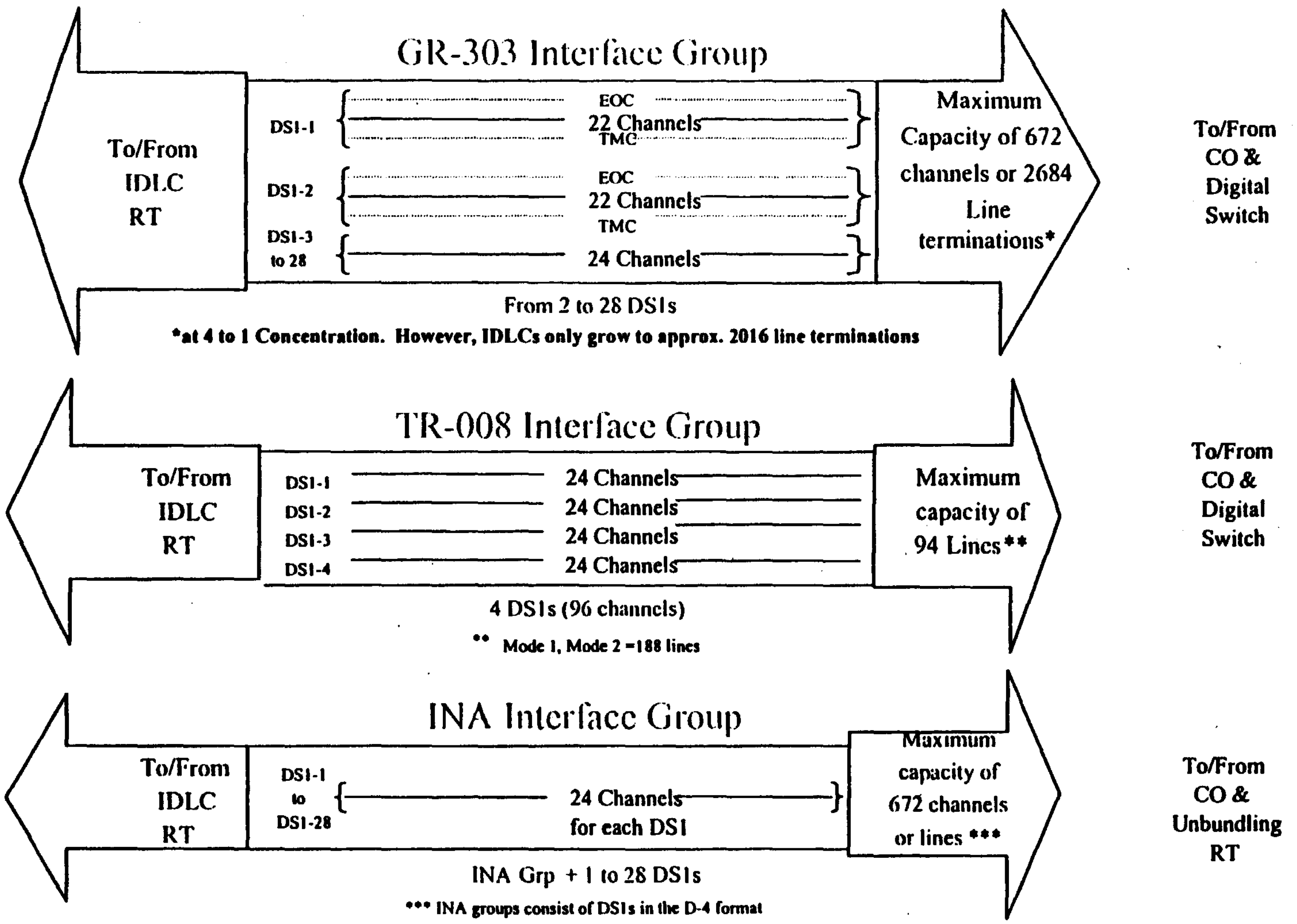

Figure 4 Interface Groups

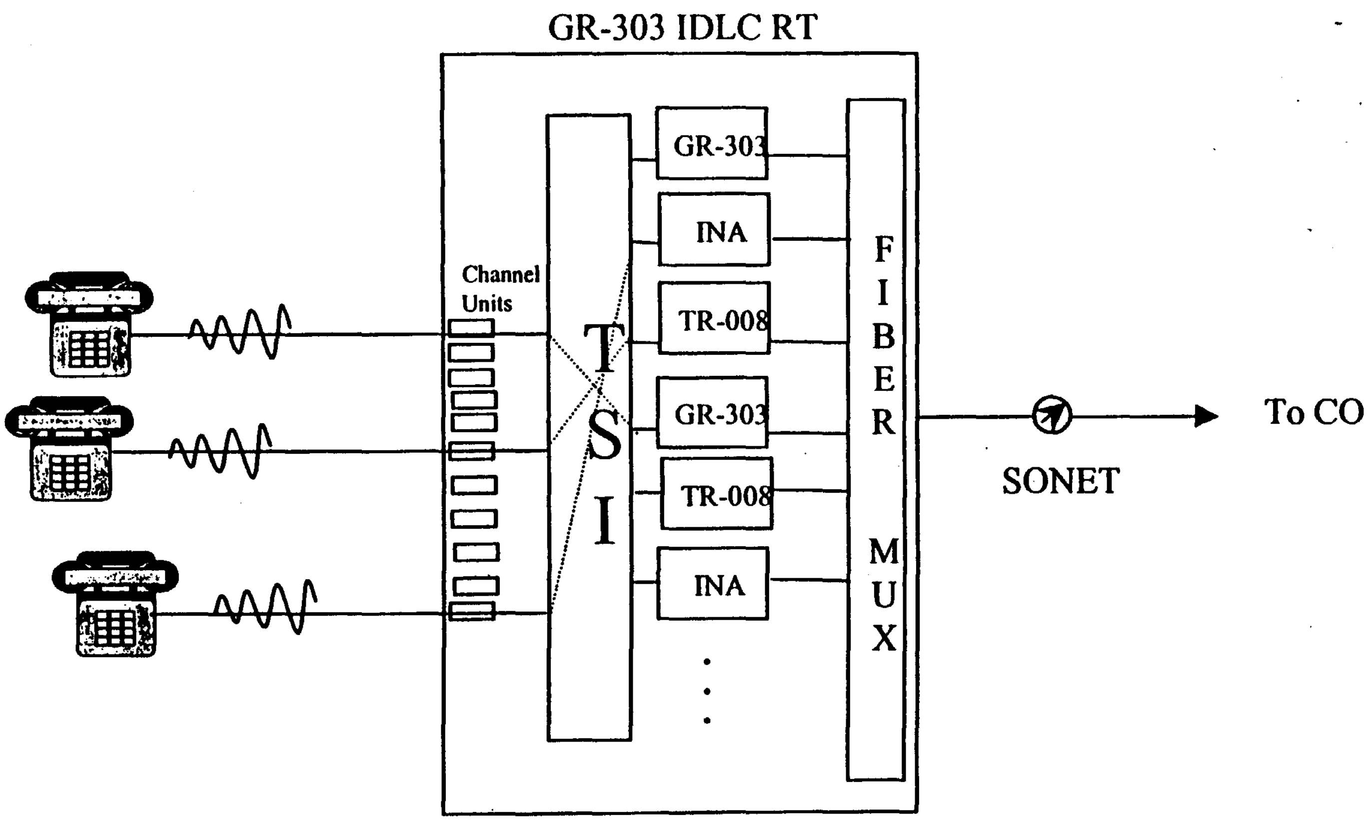

Figure 5 GR-303 IDLC RT

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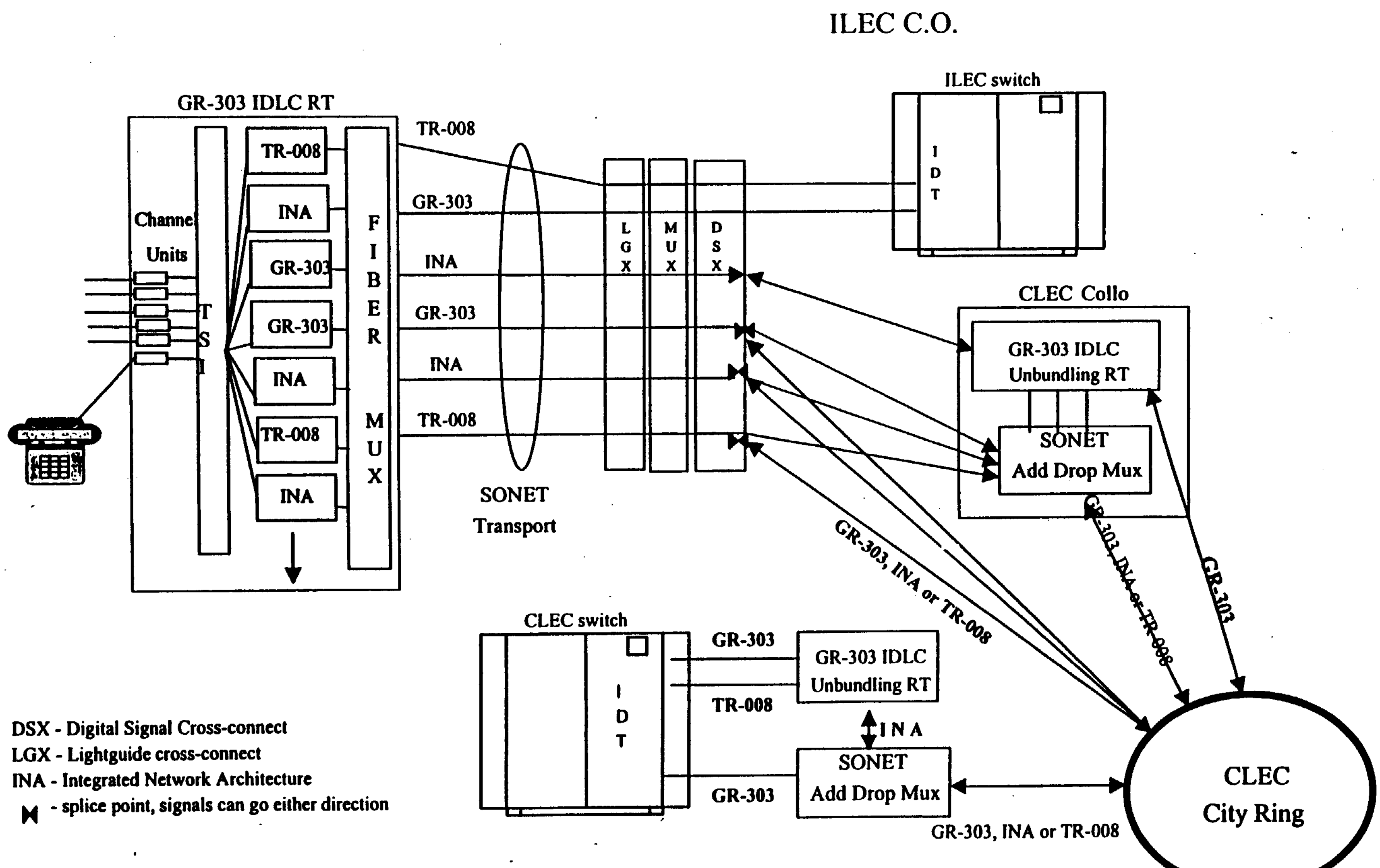

Figure 6 Multiple Switch Hosting

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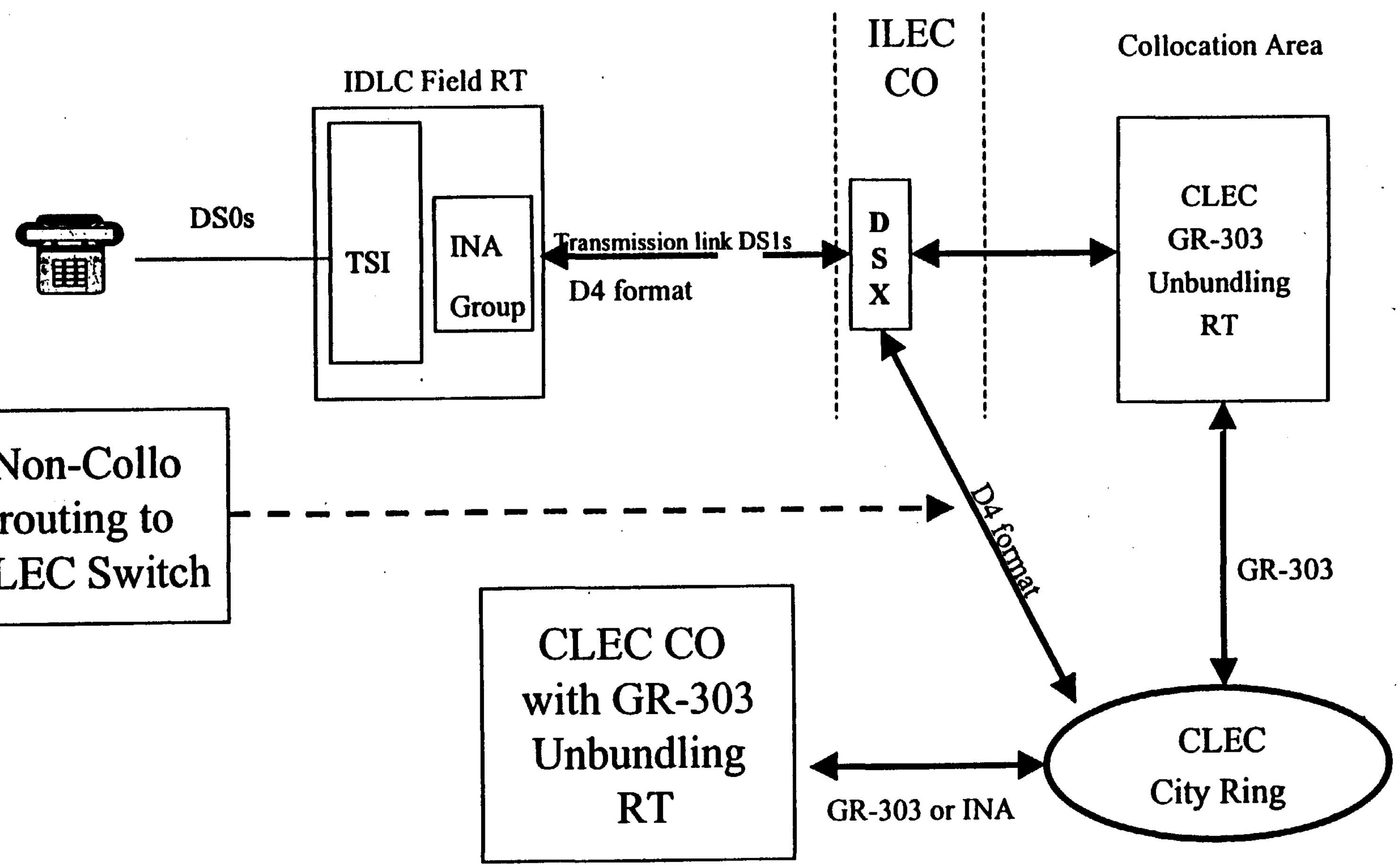
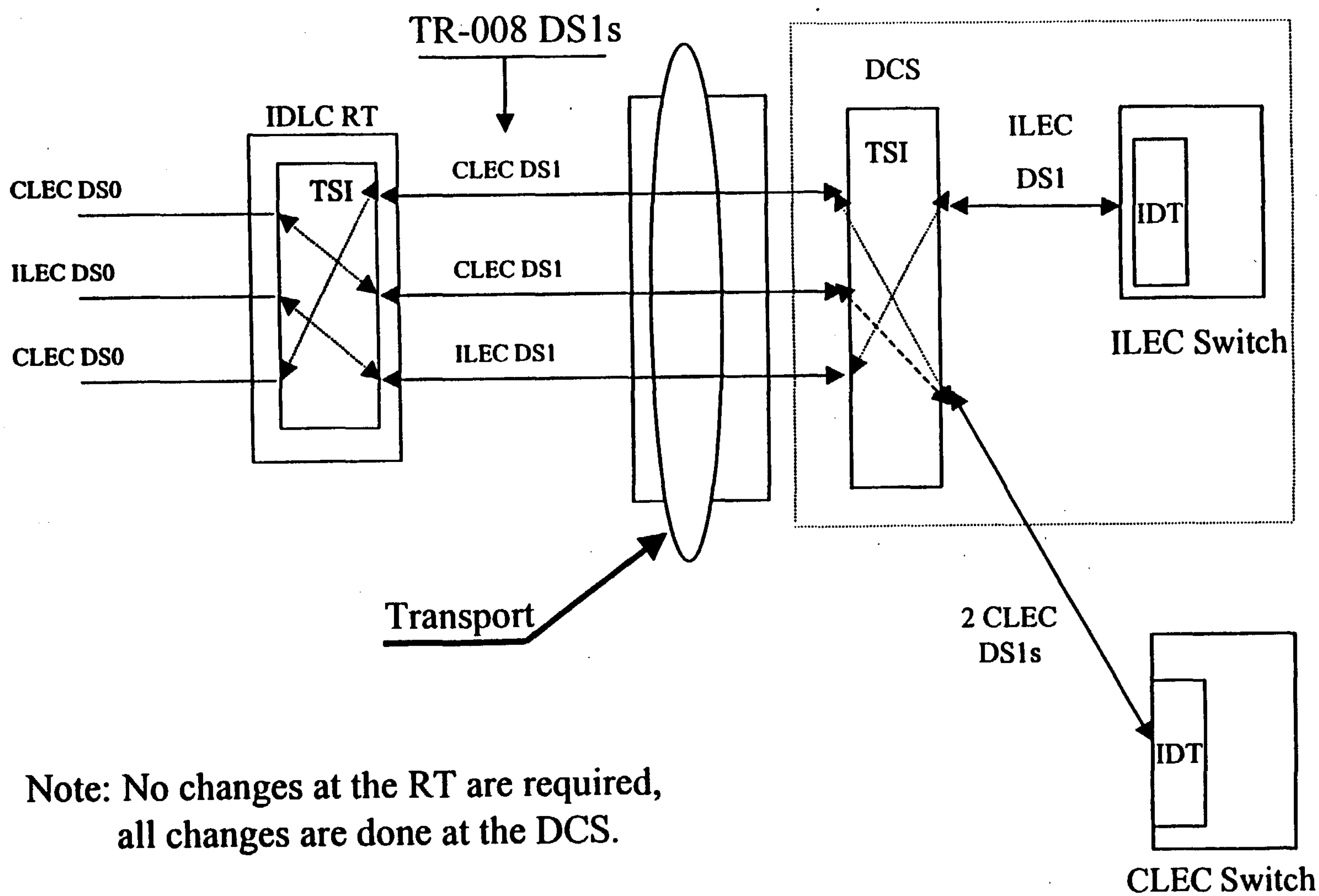


Figure 7 INA Grooming

(D-4 conversion via an unbundling RT)



Note: No changes at the RT are required,
all changes are done at the DCS.

Figure 8 Digital Cross-connect System (DCS) Grooming

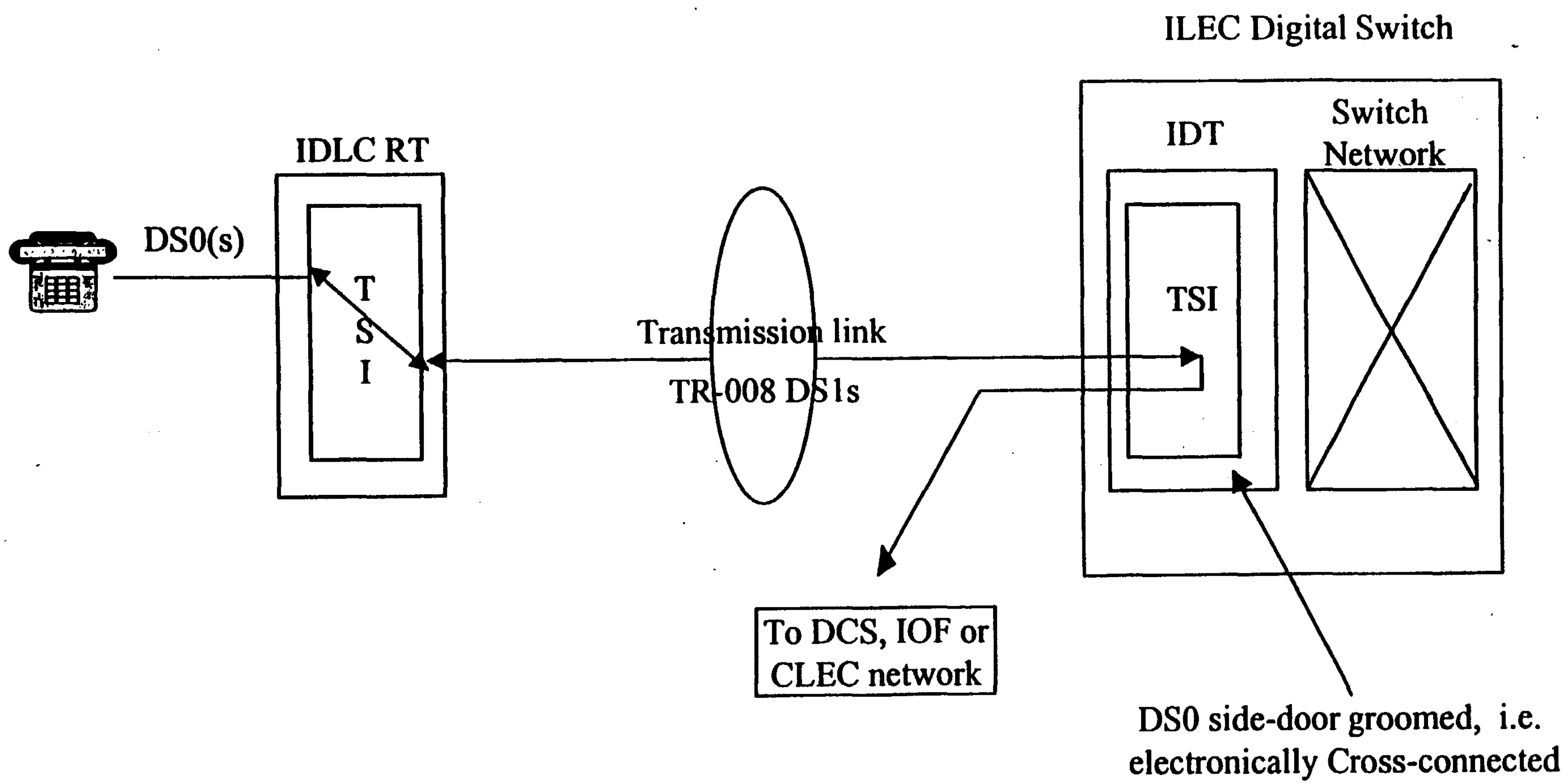


Figure 9 Side-door grooming

Reply Declaration of Francis J. Murphy, President
Network Engineering Consultants, Inc
On Behalf of GTE Service Corporation

June 10, 1999